GUEST LEADER

Will protein diversification lead to sustainable food systems in southern Africa?

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Food is essential for human life, but current food production and consumption practices are unsustainable, resulting in food insecurity for many people.[1] Over 60 million people in southern Africa are projected to experience food insecurity.[2] Food security is when people have social, physical and economic access to safe and healthy food[3] – and serves as an indicator of inclusive economic growth and sustainability.[4] Sustainability of food systems should generate food and nutrition security for future generations in the long term without compromising socio-economic and environmental foundations.[5] The Sustainable Development Commission describes a sustainable food system as one that feeds all people healthily, sustainably and equitably while being distinct, environmentally friendly and persistent.[6]

This special issue of the *South African Journal of Science*, entitled 'Sustainable Food Systems', presents a comprehensive overview of articles that reflect on the importance of local food systems to stimulate the production of healthy, safe and sustainable food resources. Southern Africa faces many modern challenges in the creation of a sustainable food system due to the combined pressure of environmental, social and economic factors. What we eat and the way we produce our food greatly impact our land, climate, biodiversity, health and well-being, and communities.[7] To make diets healthier and food systems more sustainable, southern Africa needs a platform to link researchers and their findings. Boosting the United Nations Sustainable Development Goals (SDGs) requires an urgent transformation of food systems. In reality, the current food production and consumption patterns in southern Africa creates complex sustainability challenges that are driving humanity out of a safe functional space. These challenges include diet-related health problems, food insecurity, socio-economic inequalities and environmental degradation. To effectively address these challenges will require integrated and systemic policy approaches.[8] Therefore, the contributions in this special issue draw on a range of disciplines to advance our understanding of food sustainability, food security and nutrition in southern Africa. Due to the rapid increase in the human population, a major challenge in maintaining global food security is increasing our current food production within the near future.[9]

Plant-based approach

The Commentary by Smith et al. provides stakeholder insights and policy recommendations from the InnoFoodAfrica Project on traditional African foods. To achieve the priorities of sustainable nutrition and food security solutions in South Africa, smallholder farmers need multilevel support to expand the production and consumption of indigenous and traditional African food crops (ITFC). Public education is required to transform local perspectives on protein intake and the benefits of ITFCs. Furthermore, it is suggested that the government must exempt ITFCs from value-added tax (VAT) to promote their mainstream commercial viability.

Ronquest-Ross and Sigge identify underutilised or emerging new food sources and technologies and reveal that some of these, such as indigenous African crops and food waste recovery, could be available to South Africans within 3–5 years, as they are rated highest in their ability to meet the nutritious, safe and relevant for South Africans criteria identified. One such example of an indigenous African crop is Bambara groundnut. Mabitsela et al. find that understanding the nutritional value of Bambara groundnut enables informed agricultural strategies, promoting its cultivation as a sustainable nourishment source and resilience against food insecurity.

Wyma et al. review the extent of African food-based dietary guidelines and analyse their inclusivity of plant-based dietary patterns and reveal a considerable shortfall in official recommendations for the broad spectrum of plant-based diets. The guidelines should be inclusive of plant-based dietary patterns and provide information for people who choose to eat plant-forward diets to promote healthy diets from sustainable food systems. This implies the need to offer more alternatives in plant-based food ingredients for sustainable product development. Nkoi et al. look at the impact of nitrogen fertilisation on cactus pear mucilage functionality. The functionality of the mucilage is attributed to its protein content and highlights the impact of nitrogen fertilisation on mucilage properties. Understanding how nitrogen affects mucilage functionality provides insights for crop management and sustainable food production.

Maree et al. developed a specialised sustainability model for milk and plant-based beverages, adaptable by different countries. This is achieved using the Dairy Index for Environment, Economics, and Nutrition (DiEET) model's approach that has advanced the existing understanding of the sustainability of bovine milk versus plant-based alternatives like almond, soy and oat beverages. It serves as a practical tool for stakeholders, promoting consumer education and guiding industry practices towards sustainability. Its application can enhance sustainability evaluations and contribute to global efforts in monitoring SDGs.

Agricultural outlook

Agricultural transformation must embrace diversification to meet the challenges posed by climate change, food insecurity and health threats. A cohesive agricultural education and training (AET) system is required that identifies the needs of our entire food system and delivers responsive pedagogies that combine learning sources. Fry et al. investigate the performance of the AET system using an Agricultural Innovation System lens and identify specific factors that hinder AET system performance. The absence of communication and coordination mechanisms contributes to a disenabling environment for AET supportive networking, leading to missed opportunities to facilitate between food system actors and AET providers to develop transdisciplinary research and contribute to sustainable food systems.

Habanyati and Paramasivam analyse the characteristics, strengths and limitations of various extension models in sustainable agriculture adoption. Their findings reveal that adoption rates of sustainable agricultural practices among smallholder farmers are typically low across the selected countries, with the exception of organic farming and climate-resilient practices, which exhibit medium adoption rates. Policymakers and practitioners should prioritise the development of extension strategies that are economically viable and tailored to the specific needs and constraints of smallholder farmers. This emphasises the significant role of the agro-food sector in accomplishing food sustainability achieved by developing specific strategies for a sustainable food system for the entire food chain. One of these strategies pertains to an environmentally sustainable agro-food sector that is resilient to climate change.[4]

Climate change

Climate change will radically impact the planet's water and soil, which consecutively affect food production.[4] Developing countries are attempting to mitigate climate change; however, the potential of complementary proteins for food security goals and mitigating climate impacts is still underrepresented in sustainable food research. Thatcher et al. compare the seasonal climate forecast (SCF) needs and the possible arising farming actions of commercial farmers and smallholder farmers while exploring the prospects for developing SCF tools to aid farmers. It is important to understand what farmers need to know to perceive and make use of SCFs, and to bring guidance to bridge the gap between existing SCF products and taking more informed farming actions that will increase their resilience to climate change and improve their food security. This will enable stakeholders to build seasonal climate forecasting information tools that can be easily accessed and understood by commercial and smallholder farmers alike.

Processed foods

Processed food products are widely consumed in southern Africa and will continue to be a fundamental component of the modern food supply and consumers' diet. The current challenge is to identify practical strategies to ensure that the nutritive attributes of these foods meet the needs of modern consumers. Protein-rich animal-based foods such as biltong have a very high salt content, but it is essential to ensure that these snack products keep up and adhere to modern consumers' health and nutritional demands. Opperman et al. reveal that sustainable strategies such as a 50% reduction in salt is possible without adverse effects on biltong's chemical, microbial or sensory quality, which could improve healthiness without impairing safety. Food safety culture is becoming increasingly important in the food industry as it has transitioned from a single compliance-based concept to a comprehensive organisational value that is vital for ensuring food safety.[10] Lues and Visser delve into food safety culture perspectives and suggest a food safety culture improvement pipeline by proposing six steps for continuous improvement in order to enforce additional risk-mitigation behaviours beyond compliance.

Sishi-Vilakazi and De Kock investigated the prevalence of palm oil and its derivatives in salty snack products, the presence of sustainability claims, including the Roundtable on Sustainable Palm Oil (RSPO) certification logo, and other types of claims on salty snack product labels. Their results highlight that, despite the prominence of palm oil, none of the products featured the RSPO certification logo or communicated sustainable palm oil sourcing practices. These findings reveal that while palm oil use is widespread in salty snacks, engagement with palm oil sustainability concerns is lacking. By adopting and promoting the use of certified sustainable palm oil, the industry can meet rising consumer demand for ethical practices, reduce its ecological footprint and position itself as a leader in sustainable food production.

Henning et al. determine the proximate and fatty acid compositions of smoked underutilised South African mussel *Choromytilus meridionalis*. It is a valuable food with a high protein content and a well-balanced fatty acid composition, rich in omega-3 fatty acids. Currently, this species is underutilised as a commercial food product and shows potential as a functional ready-to-eat food that could contribute to food security. Given South Africa's current obesity crisis and high burden of non-communicable diseases, an immediate transition from ultra-processed to minimally processed food will have little success. Therefore, the current research priority is to understand the higher consumption rates of processed foods and to adopt a more holistic approach to consider how food, consumer and sensory science methodologies can directly drive sustainable food consumption to influence the rate and extent of protein intake.

Food security

Innovative strategies to strengthen a pressurised African food system are required to address the challenges associated with food insecurity. Some of these strategies to address the multiple challenges include promoting environmental sustainability and sustainable resource management, supporting local economic development, and ensuring food security.[11,12] Drimie and May suggest implementing the learning journey approach to food security in a South African foodshed. Through revealing systemic issues in the local food system through direct experience of a local environment, learning journeys can co-produce knowledge in support of responses to the underlying complexity. Learning journeys move beyond extractive research towards collaborative learning that can, with concerted follow-up, result in locally appropriate bottom-up systems change.

Ferreira and Botha explore baseline insights into the food practices and needs of a South African resource-constrained community. In resource-constrained communities, the accessibility, availability and limited consumption of healthy food are strongly influenced by poverty. This argument confirms the relevance of custom-made interventions that can be used to promote healthy consumption habits in specific communities, against the background and importance of broader systems and holistic transformation that can support food security on a wider level. Drimie et al. examine fresh produce access and consumption patterns in Inchanga, eThekwini, to understand how strengthening linkages between small-scale farmers and consumers could improve local food systems. Their study indicates that cost, rather than knowledge, is the primary barrier to adequate fresh produce consumption in low-income communities, although some misinformation on food prevails. Furthermore, three factors that enable healthy eating were identified: (1) gradual food introduction; (2) growing one's own food; and (3) fresh food preference. Establishing local markets supported by appropriate public policy could simultaneously address farmers' economic needs and consumers' nutritional requirements, thus strengthening the resilience of local food systems.

South Africa's National Food and Nutrition Security Plan (NFNSP) accentuates the importance of food security as a means to ensuring that South Africa has a dependable and sufficient supply of food to meet the nutritional requirements of its population. Unfortunately, stakeholders have identified a number of challenges to the Plan's implementation. These challenges include financial constraints, specifically the size of the Plan's budget and insufficient funding.[13] Jacobs et al. used an elementary funding gap equation for a systematic calculation of the funds needed for the Plan. They built a unique data set based on historical spending information for 2018-2022 and found that national and subnational government departments dominate funding sources for food and nutrition policy activities. Furthermore, aggregation of all available funding sources revealed that authorities met only 50% of the Plan's funding needs after 4 years, and thus fell short of meeting its target. Jacobs and colleagues suggest that a holistic approach to financing food and nutrition policy is essential to achieve constitutionally protected food rights and SDG imperatives.

Protein diversification

Proteins are made up of amino acids that are essential in maintaining optimal health.[14] By 2050, the world population will exceed 9.1 billion, creating further demand for a variety of protein foods as the population grows. Alternative proteins are critical for developing sustainable food systems and climate-resilient agriculture. In Africa, where protein deficiency is prevalent, protein demand is projected to escalate over the next two decades as the continent's population doubles. The challenge lies in identifying diverse protein sources, including plant-based, cultivated and insect-based proteins, while addressing the environmental costs of traditional animal protein production, which is resource intensive and

increasingly expensive. The increase in plant proteins in current diets has resulted in multiple studies to improve the application of plant proteins in the pharmaceutical and food industries through modification methods. The latter could increase their bioavailability, techno-functionality, bioactivity and digestibility properties.[14] This brings up the issue of whether protein diversification will lead to sustainable food systems in southern Africa.

Katz-Rosene and colleagues[15] suggested three "meta-narrative coalitions" on protein sustainability which explore the heterogeneous character of protein foods that could contribute to sustainable food systems: (1) modernising proteins, which aims to centre technological innovations; (2) reconstituting proteins, which aims to introduce new protein food products and reduce animal protein consumption; and (3) regenerating proteins, which aims to restore human–nature relations within protein manufacturing and consumption practices. As confirmed by the researchers, the diversity of strategies for a sustainable protein future may be at stake and could delay food system transformation. According to the International Panel of Experts on Sustainable Food Systems[16], many of the conversations on protein sustainability are politicised and ideological (unwavering) viewpoints. Therefore, the Panel requested realignment of innovation routes through retrieving false protein claims and encouraging open and healthy conversations. A possible solution is understanding the value of protein pluralism that could ensure a more resilient transition, preventing one meta-narrative coalition from becoming more dominant and rather ensuring that all three protein meta-narratives are actively engaged in advancing the current unsustainable food system in southern Africa.[15] This raises the question: is protein pluralism a means towards enhancing resilience in the southern African food system of tomorrow?

Food systems transformation

The answer to this question most likely lies in the development of research skills to lead food systems transformation through engaged, transdisciplinary science. The Commentary of Swanepoel and Mentz-Coetzee reflects on the Food Systems Research Network for Africa (FSNet-Africa) model of strengthening research capacity for food systems transformation in Africa. Their approach demonstrates how locally grounded, stakeholder-informed research can drive sustainable change, offering a replicable model for building the next generation of African scientists committed to equitable and inclusive food systems development. Achieving sustainable food systems in southern Africa will require researchers with a diverse set of skills who can collaborate across disciplines and outside of academia. The Commentary by Wale and Gandidzanwa explores the concept of sustainable food systems transformation and asks if we are attempting to eat the elephant in one piece? Their article highlights that, while transformation is a viable vision, sustainable food systems cannot be considered unidimensional. Framing sustainability and sustainable food systems as a journey and the outcome as a continuum, enables us to realise that food systems are constantly evolving, shaped by changing ecological conditions, social demands and political contexts.

Concluding remarks

The findings from this special issue restate that enhancing African food systems requires a modern multifaceted approach that includes innovation and knowledge, technological advancements and a digital revolution, and trade and innovative financing for a sustainable future. Southern Africa's youth is its most valuable resource. The potential to harness our youth segment is inspiring but, without the required expenditure, an inadequate workforce could place a gigantic burden on African food systems. Therefore, for future purposes, it is vital to empower our youth through vocational training, entrepreneurship and continuous learning in the agri-food sector that will drive innovative solutions and purposeful leadership. Transforming current food systems into more sustainable ones will not surface automatically. It requires a transformation in food system governance, which is about how farmers, companies in agri-food chains, banks, governments, NGOs and other stakeholders interact and try to influence each other in order to achieve their objectives. Sustainable food systems require a deeper integration of many disciplinary viewpoints. It is essential to recognise the complexity of designing the right policy to improve food security for the southern African context.

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